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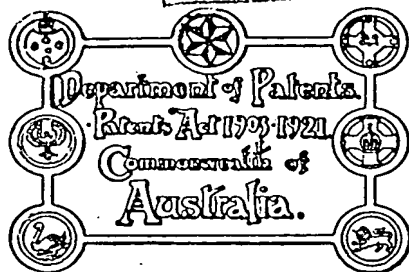
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Subsequent relating cases... 45-35-30-820243-10294-43



Application Date : 23rd Mar., 1937. No. 1145/37.

FILED 9/19,
9/346

Applicant (Actual Inventor) CLIFTON KEITH ELLIOTT.
Application and Provisional Specification Accepted, 15th April, 1937.
Complete Specification after Provisional Specification Lodged, 22nd January, 1938.
Complete Specification Accepted, 23rd March, 1938.
Acceptance Advertised (Sec. 50) .. 7th April, 1938.

Class 96.5.

Drawing attached.

COMPLETE SPECIFICATION.

"Improvements in and relating to direct-acting hydraulic shock-absorbers for motor vehicles."

I, CLIFTON KEITH ELLIOTT, of 38 Kambala Road, Bellevue Hill, in the State of New South Wales, Commonwealth of Australia, Manager, hereby declare this invention and the manner in which it is to be performed, to be fully described and ascertained in and by the following statement:—

This invention relates to hydraulic shock-absorbers of the direct-acting type for use on motor vehicles to control the compression and rebound flexure of the suspension springs of the vehicle. Shock-absorbers of this general type are described in Commonwealth Patent Specification No. 3817/36, and in which shock-absorbers the control on the springs is obtained by the control of the flow of oil from one chamber to another of the shock-absorber during flexure of the springs.

In known shock-absorbers of this type the flow of oil between the two chambers, to control the spring movement, is regulated by a relief valve and by the capacity of a relief passage, but as the capacity of this passage is constant, the resistance to the oil flowing through the passage is constant in any displaced position of the shock-absorber, and consequently the desired control or damping of the springs is not obtained.

The principal object of this invention is to provide a double acting shock-absorber of the stated type, in which a progressively increasing resistance is applied to displacement of the shock-absorber as the limit of its displacement in either direction is approached. In this manner but little resistance is offered to the initial flexure of the vehicle spring at the commencement of such flexure, but the resistance increases progressively with the amplitude of the flexure, at least after a certain displacement has occurred. By this means, considerably more effective damping of the spring flexure in either direction is obtained.

A further novel object of the invention is to provide a definite limit, by hydraulic locking, to displacement of the shock-absorber, and consequently to flexure of the springs. As a consequence, a metal-to-metal stop, with its attendant risk of fracture of the units, is avoided. This hydraulic limit is reached through gradually increasing pressure until further transference of the oil is cut off, and no further displacement of the shock-absorber can occur. The limiting position may be readily adjusted to retain spring flexure within any desired limits.

Other advantages over known shock-absorbers of this type are the low temperature of the oil which is obtained by extensive circulation, simplicity and accessibility of the valves, and an improved column support for the two telescoping units of the shock-absorber which results from the fact that the units are telescoped to a high degree before considerable pressure is applied.

10 In order to fully describe the invention reference is made to the accompanying drawings which depict a preferred embodiment of the invention, and a modified form thereof, and in which:—

15 Fig. 1 is a longitudinal elevation in part cross-section, through the shock-absorber in the normal position,

Fig. 2 is a similar view in a semi-compressed position,

20 Fig. 3 is a similar view in the fully compressed position,

Fig. 4 is a broken detailed cross-sectional elevation of the shock-absorber, in the fully compressed position, and at right angles to the views of Figs. 1, 2 and 3,

25 Fig. 5 is a cross-sectional elevation on the line 5—5 of Fig. 4,

Fig. 6 is a cross-sectional plan view on line 6—6 of Fig. 4, and

30 Fig. 7 is a longitudinal cross-sectional elevation of a modified form of the shock-absorber.

As shown more particularly in Fig. 4, the shock-absorber comprises an upper head 35 8 and a lower head 9, which are fitted for attachment respectively to the chassis and sprung undercarriage of the motor vehicle, in known manner.

Into lower head 9 is threaded the lower 40 end of a hollow oil tube 10, over the upper end of which is screwed a piston 11, which slides in a tube 12 welded on to upper head 8. Tube 12 is closed at its lower end by piston head 13 which is a neat sliding fit 45 about oil tube 10 and slides with clearance in tube 14, which is threaded on to lower head 9 and telescopes (with clearance) over tube 12 on which it is sealed by washer 15.

Piston 11 and piston-head 13 form 50 between them a secondary compression chamber 16 between tubes 10 and 12; piston-head 13 and lower head 9 form between them a primary compression chamber 17 within tube 14; and piston 11 and upper head 8 55 form between them a vacuum chamber 18 within tube 12.

A tube 19, welded on to lower head 9, forms about tube 14, and an upper part of tube 12, an oil reservoir 20 which is fitted with a filling plug 20¹. Tube 19 is slidably sealed on to tube 12 by means of an annular 5 "L" leather 21 which is clamped between a retaining ring 22, seating on an annular rib 23 on the inner surface of tube 19, and a retaining ring 24 threaded into the upper end of tube 19. 10

A dust-cover tube 25, welded on to upper head 8, telescopes over reservoir tube 19 with a clearance, and the ingress of dust is prevented by a felt washer 26 clamped between the upper end of reservoir tube 19 and the 15 retaining ring 24.

A chamber 27 within piston 11 is in open communication with the bore 10¹ of tube 10, and this chamber 27 communicates with compression chamber 16 through one-way ball valves 28, 28 retained on their seats by springs 29, 29 which are maintained in position by a washer 30 about tube 10. A one-way ball valve 31 permits a return flow of leakage oil from vacuum-chamber 18 to 25 piston chamber 27, and this valve is retained on its seat by spring 32 mounted on a pin 33 disposed across piston 11.

Reservoir 20 communicates with a cross-bore 34 in lower head 9 by means of a 30 plurality of ducts 35, 35. The bore 10¹ of oil-tube 10 communicates with cross-bore 34 past a one-way ball valve 36 maintained on its seat by a spring 37. Cross-bore 34 communicates with compression chamber 17 by 35 ducts 38, 38 past one-way ball valves 39, 39 maintained on their seats by gravity, and retained in place by washer 39¹ about tube 10.

Oil tube 10 has formed on its outer sur- 40 face, at diametrically opposite positions, two longitudinal oil grooves 40, 40. These grooves are shown in side elevation in Fig. 4, in front elevation in Figs. 1 to 3 inclusive, and in cross-section in Fig. 6. The grooves 45 40, 40 are tapered from a starting point 41 adjacent the upper end of the tube, to the deepest point, at which three spaced leakage apertures 42, 42 are formed in the wall of tube 10 connecting the grooves 40 with the 50 bore 10¹ of the tube 10. From the deepest point the grooves 40, 40 gradually run out to a vanishing point 43 adjacent the lower end of the tube 10, but spaced from such lower end. The distance from the starting 55 point 41 to the deepest point 42 is greater

than the distance from the vanishing point 43 to the deepest point 42. Tube 10 is fitted with two soft metal blow-out safety plugs 10², 10³.

5 The illustrative Figures 1 to 3, shewing the shock-absorber in various stages of compression, should be read in conjunction with Fig. 4 which illustrates in more detail the transfer of oil which controls the function of
10 the shock-absorber. The operation of the shock-absorber is as follows:—

Presume that the shock-absorber is charged with oil, that is that compression chambers 16 and 17, oil tube 10, piston chamber 27, and the ducts in the lower head 9 are fully charged, and that some excess oil remains in reservoir 20.

Fig. 1 shews the shock-absorber in the normal uncompressed condition. When the
20 vehicle wheel rises upon impact with a road irregularity, the heads 8 and 9 are forced towards each other, and the tubes mutually telescope. Lower head 9 and piston 11 commence to move upwardly in relation to upper
25 head 8 and piston-head 13, which results in the oil in primary compression chamber 17 being placed under compression, and a negative pressure being established in secondary chamber 16.

30 Oil is therefore forced to flow from chamber 17 through leakage apertures 42 into the bore 10¹ of oil tube 10, whence it passes into chamber 27 in piston 11 and thence past ball valves 28, 28 (which are forced off their
35 seats) into chamber 16, to charge the increasing volume of that chamber with the oil displaced from chamber 17, which is decreasing in volume. As oil tube 10 rises through piston head 13, the upper end of oil grooves
40 40 enter chamber 16 and present bye-passes, so that oil is also transferred through the grooves 40 directly from chamber 17 to chamber 16. As oil tube 10 continues to rise, the cross-sectional area of grooves 40,
45 40 progressively increases, so that a progressively reducing resistance is offered, during this extensive initial movement, to the compression of the shock-absorber.

When, however, the compression has pro-
50 ceeded to the point (Fig. 2) where the leakage apertures 42, 42 pass under piston head 13, the escape of oil into the bore 10¹ of tube 10 is progressively cut off, so that the resistance to the escape of oil is progres-
55 sively increased. It will be evident that when the compression has proceeded to a

point where all the leakage apertures 42, 42 have passed under piston head 13, the only escape for the oil from chamber 17 into chamber 16 is by grooves 40, 40. But as the end of the compression displacement is
5 approached, grooves 40, 40 progressively diminish in area, and the resistance to compression correspondingly progressively increases.

When the position shewn in Fig. 3 is 10 attained, piston head 13 has reached the end of grooves 40, and consequently no further oil can escape from chamber 17. This position is the end of the compression displacement, and the compressed oil remaining in 15 chamber 17 constitutes an hydraulic lock which limits the compression without metal-to-metal contact. The position of the ends 41 and 43 of grooves 40 determines the maximum displacement of the shock-absorber. 20

The volume of chamber 16 is slightly less than that of chamber 17, owing to the difference in diameters of tubes 12 and 14, and any oil which is displaced from chamber 17 and which cannot be accommodated 25 in chamber 16, is passed from bore 10¹ of oil tube 10 past ball valve 36 into cross-bore 34 and thence by ducts 35 into reservoir 20.

Also, during ascending movement of piston 11, leakage-oil which may have found its 30 way into vacuum chamber 13 is forced, by compression in that chamber, past ball valve 31 into piston chamber 27, so that chamber 18 is constantly evacuated of oil and air. 35

When the vehicle spring commences its rebound movement (from the position of Fig. 3) which it is essential to damp, upper head 8, tubes 12 and 25, and piston head 13 commence to move upwardly in relation to 40 the other parts, necessitating a re-transfer of oil from chamber 16 to chamber 17. As piston head 13 slides upwardly over oil tube 10 (from the position of Fig. 3), grooves 40, 40 are progressively uncovered and a 45 reducing resistance is applied to the initial return flow of the oil from chamber 16 through the grooves and into chamber 17, whilst simultaneously oil is forced from chamber 16, via apertures 42 to the bore of 50 tube 10, whence it flows past valve 36 to the reservoir 20.

The point of lowest resistance is reached as piston head 13 commences to slide up-
wardly over apertures 42, as thereafter the 55

only escape of oil from chamber 16 to chamber 17 is by the grooves 40, 40 which are gradually and progressively reduced in cross-sectional area, thereby imposing a progressively increasing resistance against the spring rebound as the normal position is approached. When the piston head 13 runs to the upper ends 41 of grooves 40, no further flow of oil from chamber 16 can take place, and the movement ceases under an hydraulic lock in chamber 16, as shewn in Fig. 1.

It will also be observed that as the zone of minimum resistance (the apertures 42, 42) is further from the upper end 41 of grooves 40 than from the lower end 43 thereof, a longer period of increasing resistance is offered to the rebound of the springs than is offered the initial compression thereof, which fulfils the condition for most effective spring control.

Throughout the rebound movement additional oil, to keep chamber 17 fully charged, is drawn from reservoir 20 through cross-bore 34, ducts 38 and ball valves 39.

The modified construction illustrated in Fig. 7 differs from that abovedescribed only in the construction of the oil tube 10³. In this construction the oil tube is formed along its length with a series of spaced leakage apertures 42', 42', which series of apertures terminates short of the piston 11 and lower head 9 in order to provide the hydraulic lock (abovedescribed) at either end of the displacement of the shock-absorber.

The operation of this modified form is identical with that previously described, except that all the oil transferred between chambers 16 and 17 passes through the bore 10¹ of oil tube 10³, and that the resistance against displacement of the shock-absorber is progressively increased in steps in place of a continuous increase.

It will be appreciated that as the shock-absorber is displaced from the normal position (Fig. 1) oil is forced to flow from chamber 17 into the bore 10¹ of oil tube 10³, through the large number of apertures 42' at that time in register with that chamber, and thence into chamber 16 through piston chamber 17, and through any apertures 42' at that time in register with chamber 16. It will therefore be evident that but little resistance is presented to the transferrance of oil at this time, but as oil tube 10³ ascends through piston head 13, the number of leakage apertures 42' in communication with

chamber 17 is reduced, and consequently the resistance against the flow of oil from chamber 17 is increased in steps. The maximum displacement is reached when oil tube 10³ ascends through piston head 13 to a point where the lowest aperture 42' passes thereunder, at which point the hydraulic lock in chamber 17 is established.

On the rebound movement of the shock-absorber the oil is re-transferred from chamber 16 to chamber 17 in exactly the converse manner. Thus the resistance to displacement of the shock-absorber in either direction increases progressively in steps from the beginning to the end of each displacement.

It will be appreciated from the foregoing description that the invention provides a shock-absorber of the stated type in which a progressively increasing resistance is offered to displacement of the shock-absorber as the end of the displacement in either direction is approached. This increasing resistance is caused by the progressive diminution of the cross-sectional area of oil grooves 40, and in the modified form, by the diminution of the number of escape apertures, in communication with the compression chamber from which the oil is flowing. In the construction of Fig. 3, which has oil grooves 40, the resistance does not commence to increase until after a certain displacement of the shock-absorber has taken place. In the construction of Fig. 7, however, the resistance increases throughout the displacement. This feature of increasing resistance results in very effective damping of the vehicle springs, which cannot be obtained with constant-resistance constructions.

Furthermore, an hydraulic lock in chambers 16 and 17 is obtained at the ends of the displacement in either direction respectively, so that no metal-to-metal stop is necessary. Moreover, variation of the position of the ends 41 and 43 of grooves 40 permits a simple means of controlling the extent of spring flexure.

The tubes are well telescoped before the resistance increases to a high degree, and consequently the units constitute a strong column which is not likely to collapse under severe stress. Further, the oil is circulated into and from the reservoir 20 during operation, as a result of which much of the oil heat is dissipated, and the oil temperature remains within safe limits.

Having now fully described and ascertained my said invention and the manner in which it is to be performed, I declare that what I claim is:—

1. A shock-absorber of the stated type in which oil is transferred from one chamber to another on displacement of the shock-absorber, characterised in that a progressively increasing resistance is applied to such transference of the oil as the limit of the displacement is approached.

2. A shock-absorber of the stated type in which oil is transferred from one chamber to another on displacement of the shock-absorber, in which such transference is partially or wholly through a tube communicating with both chambers, and in which a progressively increasing resistance is applied to such transference as the limit of the said displacement is approached.

3. A shock-absorber of the stated type, and including two chambers constituted by two telescoped tubes each closed at one end and by two mutually displaceable pistons associated with said tubes, and a hollow oil tube disposed through both chambers, characterised in that on displacement of the shock-absorber oil is transferred from one chamber to the other, partially or wholly through said tube.

4. A shock absorber according to any of the preceding claims, in which the transference of the oil from one chamber to the other is effected partially through a hollow oil tube in communication with both chambers, and partially through an oil groove formed in the outer surface of the hollow tube and communicating with both chambers.

5. A shock-absorber of the stated type including two pressure chambers constituted by two telescoped tubes each closed at one end and by two mutually displaceable pistons, a tube disposed through both chambers, and an oil groove formed in the outer surface of the oil tube and communicating with both pressure chambers for the transference of the oil from one pressure chamber to the other along the groove.

6. A shock-absorber according to Claim 5, in which the oil tube is hollow, and is in communication with both pressure chambers, further characterised in that a proportion of oil is transferred from one pressure chamber to the other through the hollow oil tube.

7. A shock-absorber according to any of Claims 4, 5 or 6, in which a section of the oil groove is progressively reduced in cross-sectional area towards one end where it runs out to zero, in order to apply a progressively increasing resistance to the transference of the oil from one chamber to the other as the limit of the displacement of the shock-absorber is approached.

8. A shock-absorber according to any of Claims 4, 5, 6 or 7, in which the oil groove has a zone of maximum cross-sectional area intermediate its ends, and is progressively reduced in cross-sectional area towards its ends where it runs out to zero, in order to apply a progressively increasing resistance to the transference of oil as the limit of the displacement of the shock-absorber in either direction is approached.

9. A shock-absorber according to any of Claims 4 to 8 inclusive, in which the oil tube is hollow and is in communication with both chambers, and the oil groove is in communication with the bore of the oil tube.

10. A shock-absorber of the stated type comprising two pressure chambers formed by telescoped tubes and pistons therein, and in which oil is transferred from one chamber to the other on displacement of the shock-absorber in either direction, a hollow oil tube permanently in communication with one chamber and in communication with the other chamber in certain positions of the shock-absorber, an oil groove formed along the outer surface of the oil tube and in communication with both chambers in all but the extreme positions of the displacement of the shock-absorber, and a communication between the oil groove and the bore of the oil tube intermediate the ends of the oil groove, further characterised in that from the commencement of the displacement of the shock-absorber in either direction oil is transferred from one pressure chamber to the other through both the oil groove and the bore of the oil tube, when an intermediate position of displacement is reached the communication of one chamber with the bore of the oil tube is cut off and thereafter the oil is transferred from one chamber to the other entirely through the oil groove until the limit of the displacement is reached.

11. A shock-absorber according to Claim 10, in which the oil groove is formed with

an intermediate zone of maximum cross-sectional area, and from this zone is progressively reduced in cross-sectional area towards both ends, to points where the groove 5 vanishes.

12. A shock-absorber according to Claim 11, in which the oil groove communicates with the bore of the oil tube in the zone of maximum cross-sectional area of the oil 10 groove.

13. A shock-absorber according to any of the preceding claims, in which the resistance to the transference of the oil from one chamber to the other, and hence to displacement of the shock-absorber, is progressively 15 reduced from the commencement of the displacement to a point intermediate the ends of such displacement, and that after such point the resistance is progressively increased to the limit of such displacement. 20

14. A shock-absorber according to Claim 1, in which the oil is transferred between the chambers through a hollow oil tube the bore of which communicates with both chambers 25 by spaced apertures along the tube, characterised in that the number of apertures in communication with one chamber is reduced and the number of apertures in communication with the other chamber is increased 30 during displacement of the shock-absorber, thereby giving an increasing resistance to the transference of the oil and to the displacement of the shock-absorber throughout such displacement.

15. A shock-absorber according to any of Claims 2 to 14 inclusive, in which the oil tube is hollow and is in communication with one chamber by means of a one-way 35 valve, to transfer oil from the bore of the tube into that chamber. 40

16. A shock-absorber according to any of the preceding claims, in which a limit is imposed on the displacement of the shock-absorber in either direction by means of oil 45 locked in one or other of the chambers.

17. A shock-absorber according to any of the preceding claims, in which the maximum

volume of one of the chambers is greater than the maximum volume of the other chamber, and including means for transferring oil from the greater chamber, in excess of that transferred to the smaller 5 chamber, into a reservoir.

18. A shock-absorber according to Claim 17, and including means for transferring oil from the reservoir into the greater chamber in addition to that transferred 10 thereto from the smaller chamber, for the purpose of maintaining the greater chamber filled with oil.

19. A shock-absorber according to any of the preceding claims, which comprises an 15 "upper" head and an inner telescoping tube formed thereon, a "lower" head and an outer telescoping tube formed thereon and disposed over the inner tube, a piston head formed on the end of the inner telescoping 20 tube and forming with the outer telescoping tube and the lower head a pressure chamber, an oil tube secured in the lower head and extending through the said piston head, and a piston on the "upper" end of the oil tube 25 which forms a second pressure chamber with the inner telescoping tube and the piston head thereof.

20. A shock-absorber according to Claim 19, and including a reservoir formed by a 30 tube secured to the "lower" head and enveloping the telescoping tube secured to this head.

21. A shock-absorber substantially as illustrated in Figs. 1 to 6 inclusive, and 35 described in relation thereto.

22. A shock-absorber substantially as illustrated in Fig. 7 and described in relation thereto.

Dated this 21st day of January, A.D. 1938. 40

CLIFTON KEITH ELLIOTT,

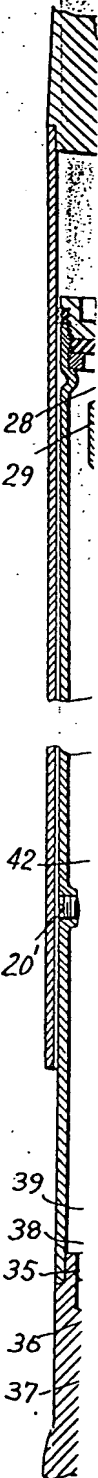
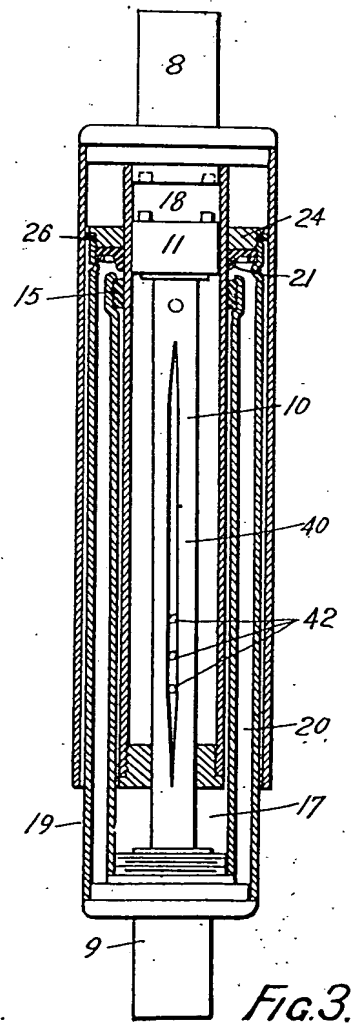
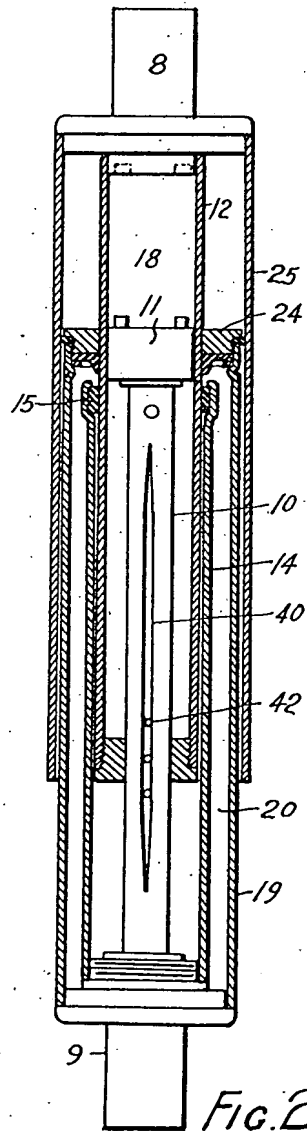
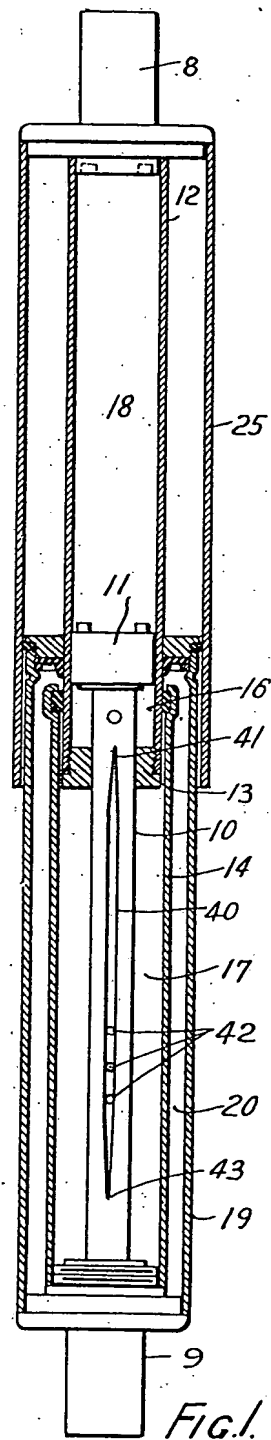
By his Patent Attorney,

STURT GRIFFITH, B.E.

(Griffith, Hassel & Griffith.)

Witness—B. Gawthorpe.

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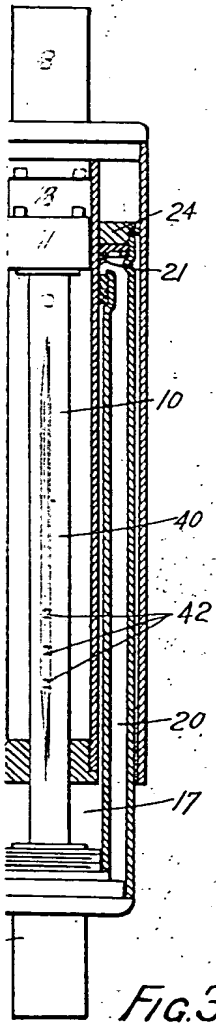


Fig. 3.

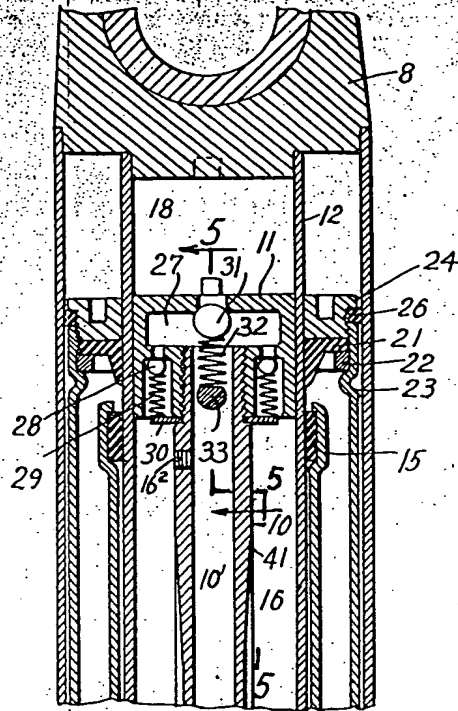


Fig. 4.

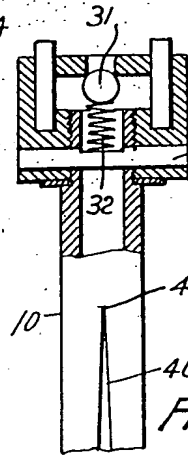


Fig. 5.

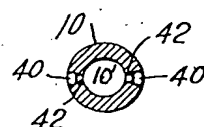
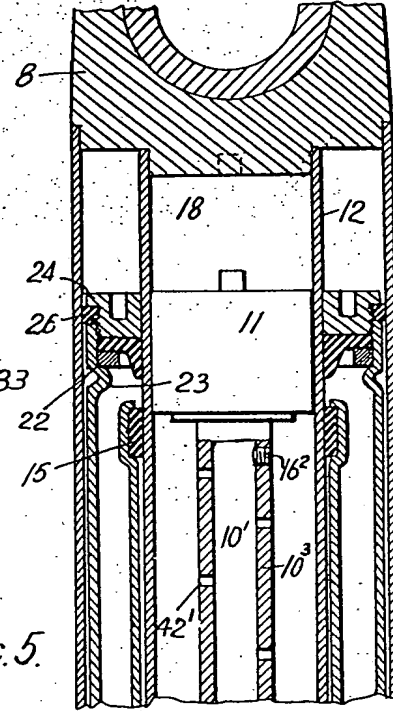


Fig. 6.

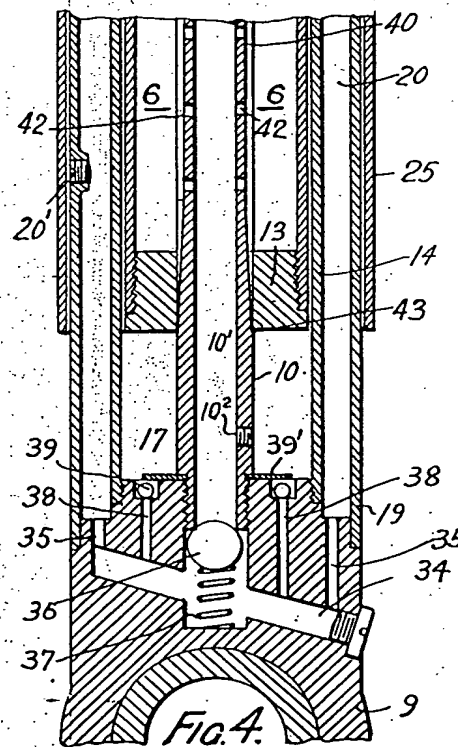


Fig. 7.

